DEPLOYING IP TELEPHONY WITH EX SERIES ETHERNET SWITCHES

Optimizing VoIP Applications with Juniper Networks Access Switches

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Table of Contents

Introduction 3
Scope 3
Description and Deployment Scenario—Method 1: VoIP Phones and End Hosts Sharing Ports 3
VoIP Phones with LLDP-MED Support 3
VoIP Phones with LLDP-MED Support—Vendor and Model List 4
Avaya LLDP-MED VoIP phone models:. 4
Cisco Systems LLDP-MED VoIP phone models:. 4
Nortel LLDP-MED VoIP phone models: 4
Phones without LLDP-MED Support 12
Using Access Port with Voice VLAN Feature (but without LLDP-MED) 12
Using Access Port with the Same VLAN ID for Both Voice and Data 12
Using Trunk Port with Native-VLAN Option 13
Description and Deployment Scenario—Method 2: Separate Ports for VoIP Phone and Endpoint Device 14
Assigning Each Port as Access Port for Different VLAN 14
Assigning Both Ports as Access Ports for Data VLAN with Voice VLAN Feature 15
Conclusion 15

Table of Figures

Figure 1: VoIP phone and end-host machine sharing a switch port 3
Figure 2: LLDP and LLDP-MED interaction between EX Series Ethernet Switch and VoIP phone 5
Figure 3: An EX Series Ethernet Switch sending out LLDP data unit. 5
Figure 4: LLDP-MED-capable VoIP phone sending LLDP-MED data unit 6
Figure 5: EX Series Ethernet Switch sending LLDP-MED data unit upon receiving LLDP-MED-Capable endpoint. 6
Figure 6: LLDP-MED-capable VoIP phone in a shared switch-port physical layout 7
Figure 7: LLDP data unit advertised by EX Series Ethernet Switch 9
Figure 8: LLDP-MED-capable VoIP phone advertising its capabilities 10
Figure 9: EX Series Ethernet Switch advertising network policy for VoIP phone via LLDP-MED. 11
Figure 10: LLDP-MED-capable phone advertising changed network policy per the EX Series Ethernet Switch 11
Figure 11: Access port with voice VLAN feature 12
Figure 12: Both VoIP phone and endpoint device in the same VLAN. 12
Figure 13: Trunk port with Native-VLAN option 13
Figure 14: Separate ports for VoIP and endpoint device 14
Figure 15: Each port as access port for different VLAN 14
Figure 16: Both ports as access ports of data VLAN with voice VLAN feature 15

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Introduction

Juniper Networks® EX Series Ethernet Switches offer a number of features for optimizing IP telephony deployments. This application note describes how voice over IP (VoIP) phones can be deployed in conjunction with endpoint hosts such as desktop or laptop computers; provides background information on Link Layer Discovery Protocol (LLDP) and LLDP-Media Endpoint Discovery (LLDP-MED); and describes the interaction between VoIP phones and EX Series Ethernet Switches.

Scope

While this document can't cover all of the physical configurations that are possible on the EX Series, it does present configuration examples for the most common applications seen today. In particular, this document addresses configurations relating to:

- VoIP phones and endpoint hosts sharing the same switch port
- Using separate ports for VoIP phones and an endpoint host

This application note applies to the Juniper Networks EX2200, EX3200, EX3300, EX4200, EX6200 and EX8200 Ethernet Switches as solutions for existing and new enterprise IP telephony deployments.

Description and Deployment Scenario—Method 1: VoIP Phones and End Hosts Sharing Ports

The most common enterprise VoIP edge deployment consists of VoIP phones and end-host machines connected in series and attached to a single switch port. This physical layout reduces switch port requirements by allowing multiple end user devices to share a connection rather than occupy their own individual switch ports, thereby reducing the total number of switches deployed, as well as capital and operational expenses.

However, when VoIP phones and end hosts share a switch port, sound quality on an IP phone call will suffer when large bursts of data traffic create network congestion that leads to packet loss or delay. To overcome this problem, it is desirable to provide voice traffic with a higher level of service due to its susceptibility to jitter, delay and packet loss.

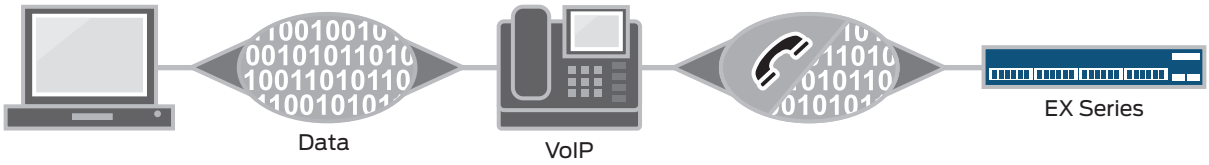

Figure 1: VoIP phone and end-host machine sharing a switch port

This is accomplished by separating voice and data traffic into separate broadcast domains or VLANs—an essential capability for any robust VoIP solution. The EX Series offers a Voice VLAN feature that enables otherwise standard access ports to accept both untagged (data) and tagged (voice) traffic from directly connected VoIP phones, and separate these traffic streams into separate VLANs (namely data-VLAN and voip-VLAN).

The EX Series can separate data and voice traffic on the switch port where Voice VLAN is implemented. However, the phone is still vulnerable to large bursts of data from the attached end host on its own phone port, depending on the phone's ability to prioritize its own voice traffic over the end-host data traffic before forwarding both streams to the switch. To solve this problem, the user can take the "separate port" approach in which the phone and the end host are connected to separate ports on the switch. This solution is covered in the "Method 2" section of this paper.

VoIP Phones with LLDP-MED Support

Before exploring the actual interaction between VoIP phones and the EX Series, it's important to understand the fundamentals of two industry-standard protocols: Link Layer Discovery Protocol (LLDP) and LLDP-Media Endpoint Discovery (LLDP-MED). This section will provide a brief overview covering the basics of these two protocols.

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LLDP, also known as IEEE 802.1AB, is a standards-based Layer 2 protocol that allows network devices to advertise and receive their identity and capabilities on a LAN segment, most of them directly connected. This protocol, developed as an open standard, was modeled after various vendor-specific proprietary discovery protocols such as Cisco Discovery Protocol (CDP), Extreme Discovery Protocol (EDP), Nortel Discovery Protocol (NDP) and others. The EX Series has embraced the open, standards-based LLDP as their Layer 2 discovery protocol.

LLDP-MED is an extension to the IEEE 802.1AB standard published by the Telecommunications Industry Association (TIA). This standard, ANSI/TIA-1057, is designed to support interoperability between VoIP endpoint devices and other networking end-devices, focusing mainly on discovery to facilitate information sharing between endpoints and network infrastructure devices. Some of the benefits of LLDP-MED include:

- **Network policy discovery** that allows endpoints and switches to advertise their VLAN IDs (for example, voip-VLAN), Layer 2 Priority and Differentiated Services Code Point (DSCP)
- **Power over Ethernet (PoE) management** that allows endpoint devices to advertise their actual PoE levels and enables power sourcing equipment (like switches) to budget their power allocation accordingly
- **Inventory management discovery** that stores endpoint device information such as vendor, model firmware and serial number on the switch and makes it accessible to network management systems for inventory reporting purposes

VoIP Phones with LLDP-MED Support—Vendor and Model List

Some VoIP phone vendors and their respective LLDP-MED-compatible VoIP phones are listed below. The information in this section, current as of May 2008, has been gathered from publicly available sources such as vendor websites. To confirm the latest VoIP phones with LLDP-MED support, consult each vendor's product documentation.

Avaya LLDP-MED VoIP phone models:

- 9600 Series with firmware release 1.2.1
- 4600 Series with firmware release 2.6

Cisco Systems LLDP-MED VoIP phone models:

- 7906G
- 7911G
- 7931G
- 7941G/7941G-GE
- 7942G
- 7945G
- 7961G/7961G-GE
- 7962G
- 7965G
- 7970G/ 7971G-GE
- 7975G

Nortel LLDP-MED VoIP phone models:

While LLDP and LLDP-MED help simplify IP telephony deployments, it is important to understand how they interact with the VoIP phones and switches—specifically with the EX Series, which will not advertise their capabilities via LLDP-MED when a port is first brought online.

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Figure 2 provides an overview of the LLDP/LLDP-MED message exchange sequence when an LLDP-MED-enabled VoIP phone is first connected to a switch port on an EX Series Ethernet Switch.

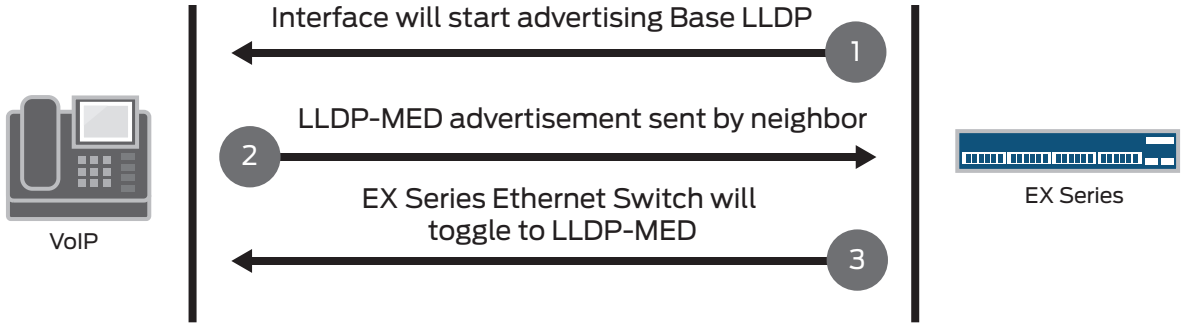

Figure 2: LLDP and LLDP-MED interaction between EX Series Ethernet Switch and VoIP phone

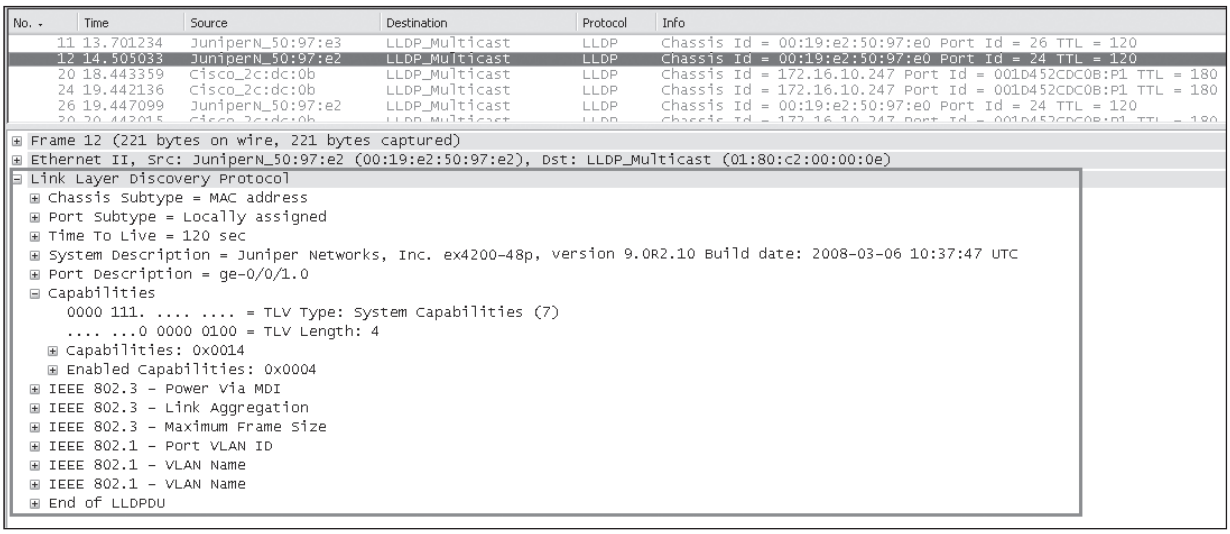
No. Time Source Destination Protocol Info
11 13.701234 JuniperN_50:97:e3 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 26 TTL = 120
12 14.505033 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
20 18.443359 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
24 19.442136 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
26 19.447099 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
Frame 12 (221 bytes on wire, 221 bytes captured)
Ethernet II, Src: JuniperN_50:97:e2 (00:19:e2:50:97:e2), Dst: LLDP_Multicast (01:80:c2:00:00:0e)
Link Layer Discovery Protocol
Chassis Subtype = MAC address
Port Subtype = Locally assigned
Time To Live = 120 sec
System Description = Juniper Networks, Inc. ex4200-48p, version 9.0R2.10 Build date: 2008-03-06 10:37:47 UTC
Port Description = ge-0/0/1.0
Capabilities
0000 111. .... = TLV Type: System Capabilities (7)
....0 0000 0100 = TLV Length: 4
Capabilities: 0x0014
Enabled Capabilities: 0x0004
IEEE 802.3 - Power Via MDI
IEEE 802.3 - Link Aggregation
IEEE 802.3 - Maximum Frame Size
IEEE 802.1 - Port VLAN ID
IEEE 802.1 - VLAN Name
IEEE 802.1 - VLAN Name
End of LLDPDU

Figure 3: An EX Series Ethernet Switch sending out LLDP data unit

This interaction can be seen in detail in the highlighted section of the packet capture shown in Figure 3. Note that LLDP, as defined in IEEE 802.1AB, sends the data unit to a well-known IEEE multicast address (01:80:c2:00:00:0e). This address is defined within a range of addresses reserved by the IEEE for protocols that are to be confined to an individual LAN segment.

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On the other hand, LLDP-MED-capable VoIP phones will advertise their capabilities using LLDP-MED from the start. Note that the fields within the section named TIA indicate LLDP-MED (Figure 4).

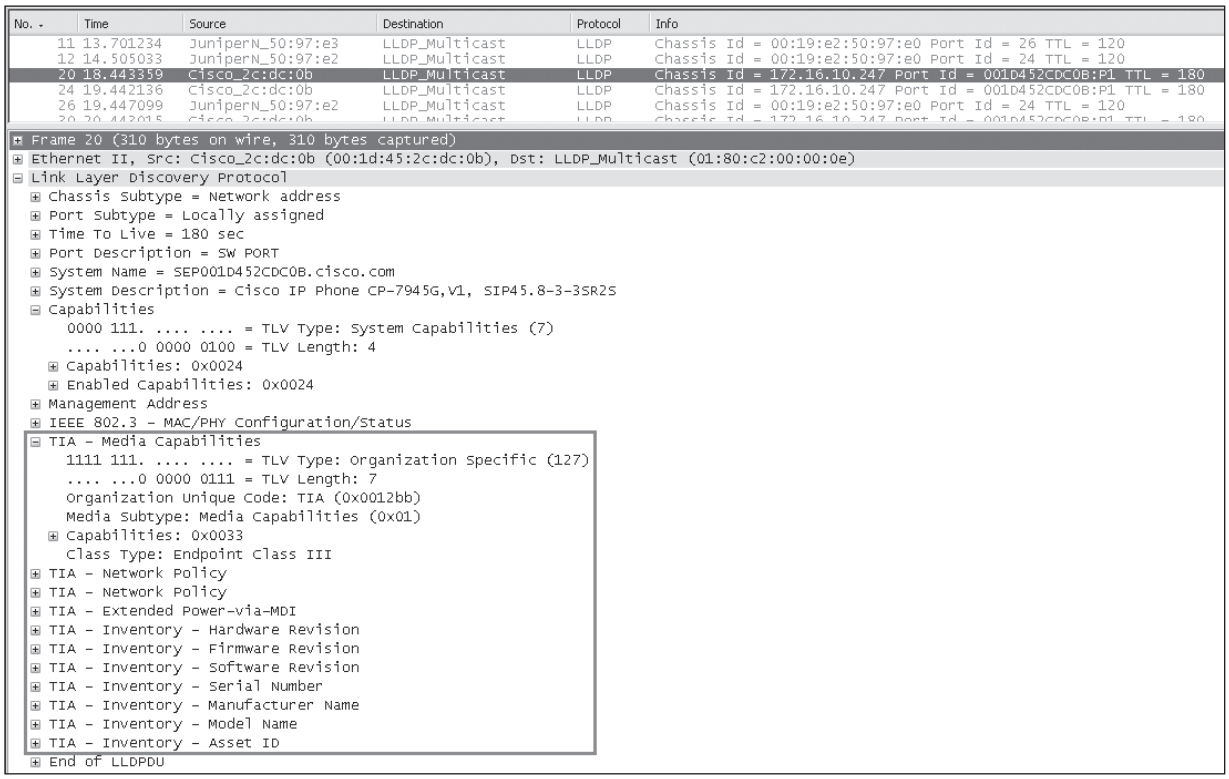
No. Time Source Destination Protocol Info
11 13.701234 JuniperN_50:97:e3 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 26 TTL = 120
12 14.505033 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
20 18.443359 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
24 19.442136 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
26 19.447099 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
Frame 20 (310 bytes on wire, 310 bytes captured)
Ethernet II, Src: Cisco_2c:dc:0b (00:1d:45:2c:dc:0b), Dst: LLDP_Multicast (01:80:c2:00:00:0e)
Link Layer Discovery Protocol
Chassis Subtype = Network address
Port Subtype = Locally assigned
Time To Live = 180 sec
Port Description = SW PORT
System Name = SEP001D452CDC0B.cisco.com
System Description = Cisco IP Phone CP-7945G,V1, SIP45.8-3-3SR2S
Capabilities
0000 111. .... = TLV Type: System Capabilities (7)
....0 0000 0100 = TLV Length: 4
Capabilities: 0x0024
Enabled Capabilities: 0x0024
Management Address
IEEE 802.3 - MAC/PHY Configuration/Status
TIA - Media Capabilities
1111 111. .... = TLV Type: Organization Specific (127)
....0 0000 0111 = TLV Length: 7
Organization Unique Code: TIA (0x0012bb)
Media Subtype: Media Capabilities (0x01)
Capabilities: 0x0033
Class Type: Endpoint Class III
TIA - Network Policy
TIA - Network Policy
TIA - Extended Power-via-MDI
TIA - Inventory - Hardware Revision
TIA - Inventory - Firmware Revision
TIA - Inventory - Software Revision
TIA - Inventory - Serial Number
TIA - Inventory - Manufacturer Name
TIA - Inventory - Model Name
TIA - Inventory - Asset ID
End of LLDPDU

Figure 4: LLDP-MED-capable VoIP phone sending LLDP-MED data unit

Upon receiving the LLDP-MED data units from the neighboring end device (VoIP phone), the EX Series will start advertising its capabilities using LLDP-MED (Figure 5).

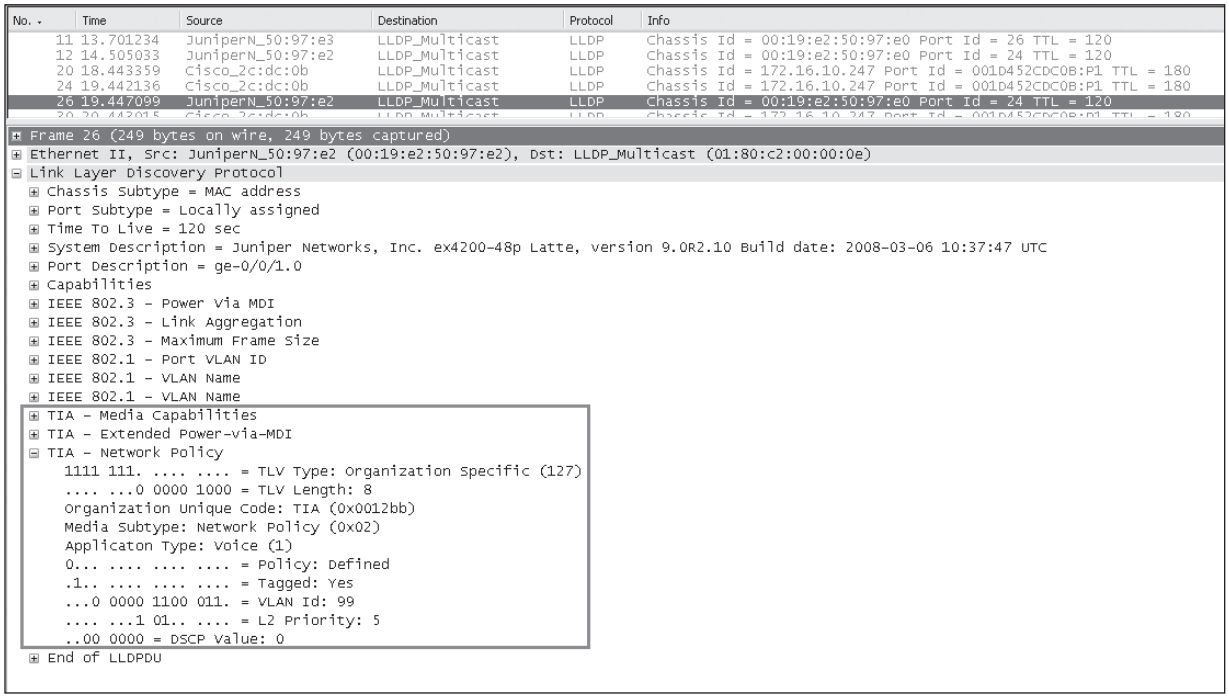
No. Time Source Destination Protocol Info
11 13.701234 JuniperN_50:97:e3 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 26 TTL = 120
12 14.505033 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
20 18.443359 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
24 19.442136 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
26 19.447099 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
Frame 26 (249 bytes on wire, 249 bytes captured)
Ethernet II, Src: JuniperN_50:97:e2 (00:19:e2:50:97:e2), Dst: LLDP_Multicast (01:80:c2:00:00:0e)
Link Layer Discovery Protocol
Chassis Subtype = MAC address
Port Subtype = Locally assigned
Time To Live = 120 sec
System Description = Juniper Networks, Inc. ex4200-48p Latte, version 9.0R2.10 Build date: 2008-03-06 10:37:47 UTC
Port Description = ge-0/0/1.0
Capabilities
IEEE 802.3 - Power Via MDI
IEEE 802.3 - Link Aggregation
IEEE 802.3 - Maximum Frame Size
IEEE 802.1 - Port VLAN ID
IEEE 802.1 - VLAN Name
IEEE 802.1 - VLAN Name
TIA - Media Capabilities
TIA - Extended Power-via-MDI
TIA - Network Policy
1111 111. .... = TLV Type: Organization Specific (127)
....0 0000 1000 = TLV Length: 8
Organization Unique Code: TIA (0x0012bb)
Media Subtype: Network Policy (0x02)
Applicaton Type: Voice (1)
0... .... = Policy: Defined
.1.. .... = Tagged: Yes
...0 0000 1100 011. = VLAN Id: 99
....1 01.. .... = L2 Priority: 5
..00 0000 = DSCP Value: 0
End of LLDPDU

Figure 5: EX Series Ethernet Switch sending LLDP-MED data unit upon receiving LLDP-MED-Capable endpoint

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Using Voice VLAN Support with LLDP-MED

As mentioned earlier, the Voice VLAN feature enables EX Series switches to accept both untagged (data) and tagged (voice) traffic from directly connected VoIP phones, and split these traffic streams into different VLANs. This feature delivers its greatest benefit when connected to a VoIP phone capable of advertising and receiving LLDP-MED data units, including VLAN ID assignments, because it essentially enables the EX Series to deliver a "plug-and-play" IP telephony solution (Figure 6).

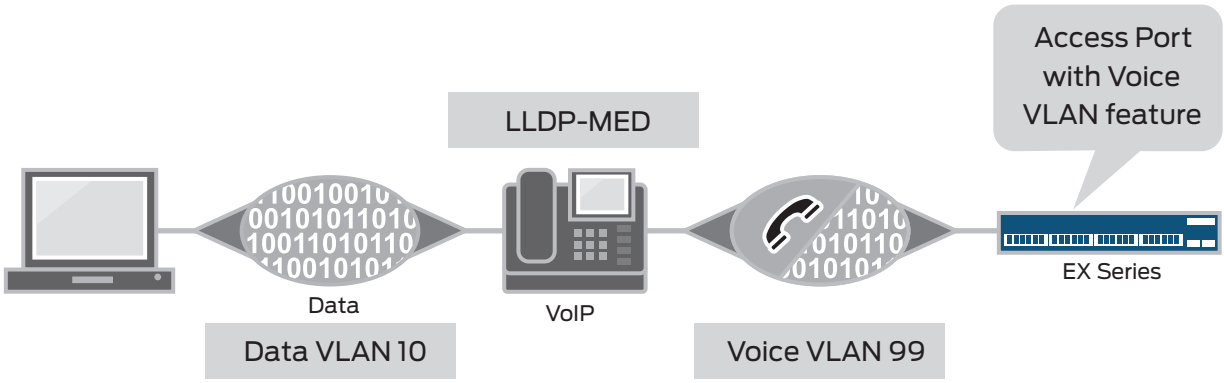

Figure 6: LLDP-MED-capable VoIP phone in a shared switch-port physical layout

The following section details the implementation shown in Figure 6.

The configuration of EX Series switches with the Voice VLAN feature in a typical shared switch-port implementation with LLDP-MED-capable VoIP phones is as follows:

```
user@switch# set protocols lldp interface all
user@switch# set protocols lldp-med interface all


user@switch# set vlans voip-only vlan-id 99
user@switch# set vlans data-only vlan-id 10

user@switch# set interfaces ge-0/0/1 unit 0 family ethernet-switching port-mode
access
user@switch# set interfaces ge-0/0/1 unit 0 family ethernet-switching vlan member
data-only

user@switch# set ethernet-switching-options voip interface ge-0/0/1.0 vlan voip-
only
user@switch# set ethernet-switching-options voip interface ge-0/0/1.0 forwarding-
class expedited-forwarding

user@switch# commit
```

Although these strings of data may appear overwhelming to someone who is unfamiliar with Juniper Networks Junos® operating system, the configuration semantics are actually very straightforward. A closer inspection of the individual functional blocks will help explain what is happening and clarify the benefit of the Voice VLAN feature.

In the first functional block (below), the protocols to be used—LLDP and LLDP-MED—are turned on. Although these protocols are turned on by default on any EX Series switch, it is specifically called out here for clarification.

```
user@switch# set protocols lldp interface all
user@switch# set protocols lldp-med interface all
```

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In the second functional block (below), two VLANs are defined: one for voice and one for data. The actual VLAN IDs used on this example are arbitrary; the EX Series allows VLAN ID configurations up to 4096.

```
user@switch# set vlans voip-only vlan-id 99
user@switch# set vlans data-only vlan-id 10
```

In the third functional block (below), the interface "ge-0/0/1" has been configured as an access port belonging to the data VLAN ("data-only"). Notice that there is no configuration needed for the voice VLAN, which is covered in the next section.

```
user@switch# set interfaces ge-0/0/1 unit 0 family ethernet-switching port-mode
access
user@switch# set interfaces ge-0/0/1 unit 0 family ethernet-switching vlan member
data-only
```

In the fourth functional block (below), the Voice VLAN feature is configured under the Ethernet-switching-options stanza with the voip option (see the "ethernet-switching-options voip" command below). Here the actual VLAN to be used for voice will be defined, as well as the level of service that will be provided for traffic received on that VLAN—in this example, "expedited-forwarding."

```
user@switch# set ethernet-switching-options voip interface ge-0/0/1.0 vlan voip-
only
user@switch# set ethernet-switching-options voip interface ge-0/0/1.0 forwarding-
class expedited-forwarding
```

In the fifth functional block (below), the configuration is committed in Junos OS, making it active.

```
user@switch# commit
```

Upon completion, the LLDP-MED configuration can be verified on the EX Series, as shown below.

```
user@switch> show lldp

LLDP                      : Enabled
Advertisement interval    : 30 seconds
Transmit delay            : 2 seconds
Hold timer                : 4 seconds
Config Trap Interval      : 60 seconds
Connection Hold timer     : 300 seconds

LLDP MED                  : Enabled
MED fast start count      : 3 Packets

Interface      LLDP       LLDP-MED
all           Enabled     Enabled
```


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Advertisements sent by neighboring VoIP phones can also be viewed. A Cisco VoIP phone was used for the following example:

```
user@switch> show lldp neighbors interface ge-0/0/1.0

LLDP Neighbor Information:
Index: 1 Time to live: 180 Time mark: Thu Mar 6 22:35:53 2008 Age: 28 secs

Local interface            : ge-0/0/1.0
Chassis type               : Network address
Chassis ID                 : 172.16.10.10
Port type                  : Locally assigned
Port ID                    : xxxxxxxxxxxx:P1
Port description           : SW PORT
System name                : SEPxxxxxxxxxx
System description         : Cisco IP Phone CP-7945G,V1, SIP45.8-3-3SR2S

System capabilities
                    Supported: Bridge Telephone
                    Enabled  : Bridge Telephone

Management address
                    Type     : IPv4
                       Address  : 172.16.10.10
Media endpoint class: Class III Device

MED Hardware revision   : 1
MED Firmware revision   : tnp45.8-3-1-21.bin
MED Software revision   : SIP45.8-3-3SR2Sbin
MED Serial number       : xxxxxxxxxxxxxxx
MED Manufacturer name   : Cisco Systems, Inc.
MED Model name          : CP-7945Gstem
MED Asset id : CP-7
```

By using a packet capture tool, the details of the actual interaction between the EX Series and LLDP-MED-capable VoIP device can be viewed (see Figures 7 through 10).

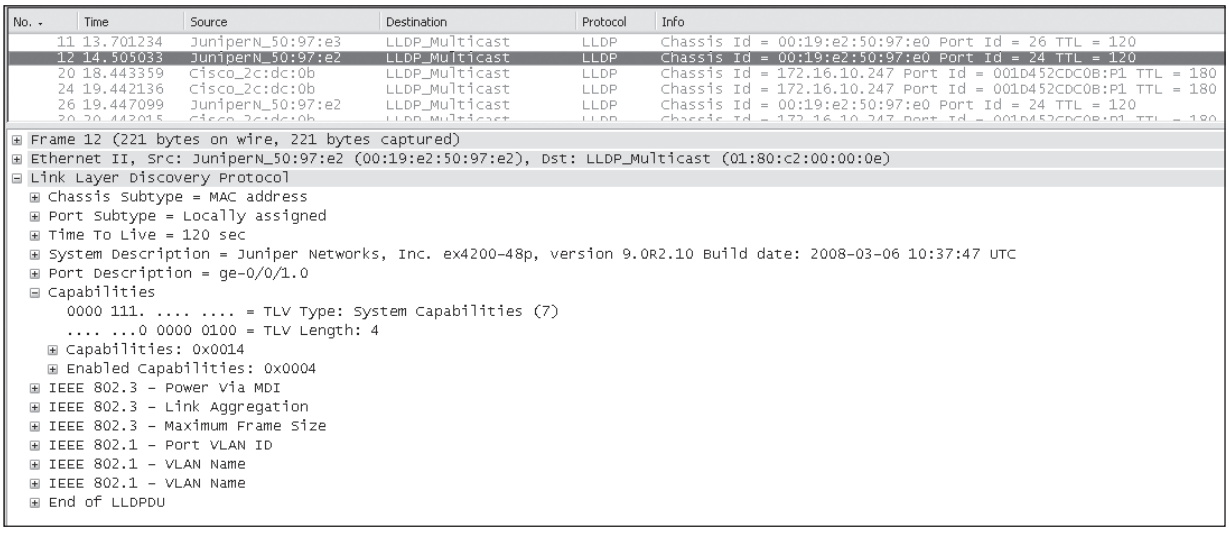
No. Time Source Destination Protocol Info
11 13.701234 JunipernN_50:97:e3 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 26 TTL = 120
12 14.505033 JunipernN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
20 18.443359 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
24 19.442136 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
26 19.447099 JunipernN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
Frame 12 (221 bytes on wire, 221 bytes captured)
Ethernet II, Src: JunipernN_50:97:e2 (00:19:e2:50:97:e2), Dst: LLDP_Multicast (01:80:c2:00:00:0e)
Link Layer Discovery Protocol
Chassis Subtype = MAC address
Port Subtype = Locally assigned
Time To Live = 120 sec
System Description = Juniper Networks, Inc. ex4200-48p, version 9.0R2.10 Build date: 2008-03-06 10:37:47 UTC
Port Description = ge-0/0/1.0
Capabilities
0000 111. .... = TLV Type: System Capabilities (7)
....0 0000 0100 = TLV Length: 4
Capabilities: 0x0014
Enabled Capabilities: 0x0004
IEEE 802.3 - Power Via MDI
IEEE 802.3 - Link Aggregation
IEEE 802.3 - Maximum Frame Size
IEEE 802.1 - Port VLAN ID
IEEE 802.1 - VLAN Name
IEEE 802.1 - VLAN Name
End of LLDPDU

Figure 7: LLDP data unit advertised by EX Series Ethernet Switch

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As discussed previously regarding the interaction between LLDP and LLDP-MED, the EX Series will initially advertise its capabilities using LLDP only, as shown in Figure 7. The LLDP-MED-capable phone will advertise its capabilities using LLDP-MED, as shown in Figure 8. A Cisco IP phone 7945G was used in the following example.

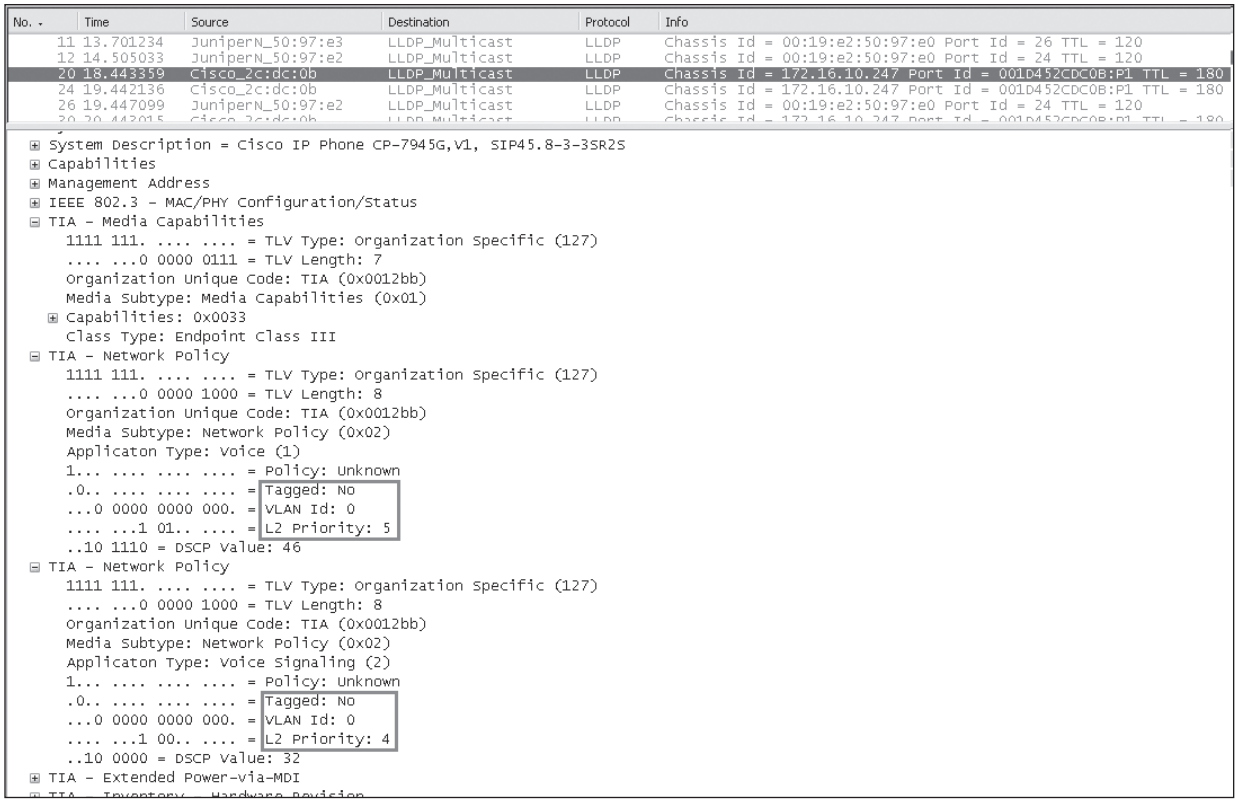
No. Time Source Destination Protocol Info
11 13.701234 JuniperN_50:97:e3 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 26 TTL = 120
12 14.505033 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
20 18.443359 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
24 19.442136 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
26 19.447099 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
System Description = Cisco IP Phone CP-7945G,V1, SIP45.8-3-3SR2S
Capabilities
Management Address
IEEE 802.3 - MAC/PHY Configuration/Status
TIA - Media Capabilities
1111 111. .... = TLV Type: Organization Specific (127)
....0 0000 0111 = TLV Length: 7
Organization Unique Code: TIA (0x0012bb)
Media Subtype: Media Capabilities (0x01)
Capabilities: 0x0033
Class Type: Endpoint Class III
TIA - Network Policy
1111 111. .... = TLV Type: Organization Specific (127)
....0 0000 1000 = TLV Length: 8
Organization Unique Code: TIA (0x0012bb)
Media Subtype: Network Policy (0x02)
Applicaton Type: Voice (1)
1... .... = Policy: Unknown
.0.. .... = Tagged: No
...0 0000 0000 000. = VLAN Id: 0
....1 01.. .... = L2 Priority: 5
..10 1110 = DSCP Value: 46
TIA - Network Policy
1111 111. .... = TLV Type: Organization Specific (127)
....0 0000 1000 = TLV Length: 8
Organization Unique Code: TIA (0x0012bb)
Media Subtype: Network Policy (0x02)
Applicaton Type: Voice Signaling (2)
1... .... = Policy: Unknown
.0.. .... = Tagged: No
...0 0000 0000 000. = VLAN Id: 0
....1 00.. .... = L2 Priority: 4
..10 0000 = DSCP Value: 32
TIA - Extended Power-via-MDI

Figure 8: LLDP-MED-capable VoIP phone advertising its capabilities

Sections preceded with a TIA heading show that the VoIP phone is LLDP-MED-capable; its media capabilities and network policy can also be viewed. Note that the VLAN ID sent by the VoIP phone shows the voice VLAN ID as 0 with a Layer 2 (802.1p) priority of 5 for voice traffic and a VLAN ID of 0 with a Layer 2 (802.1p) priority of 4 for voice-signaling traffic.

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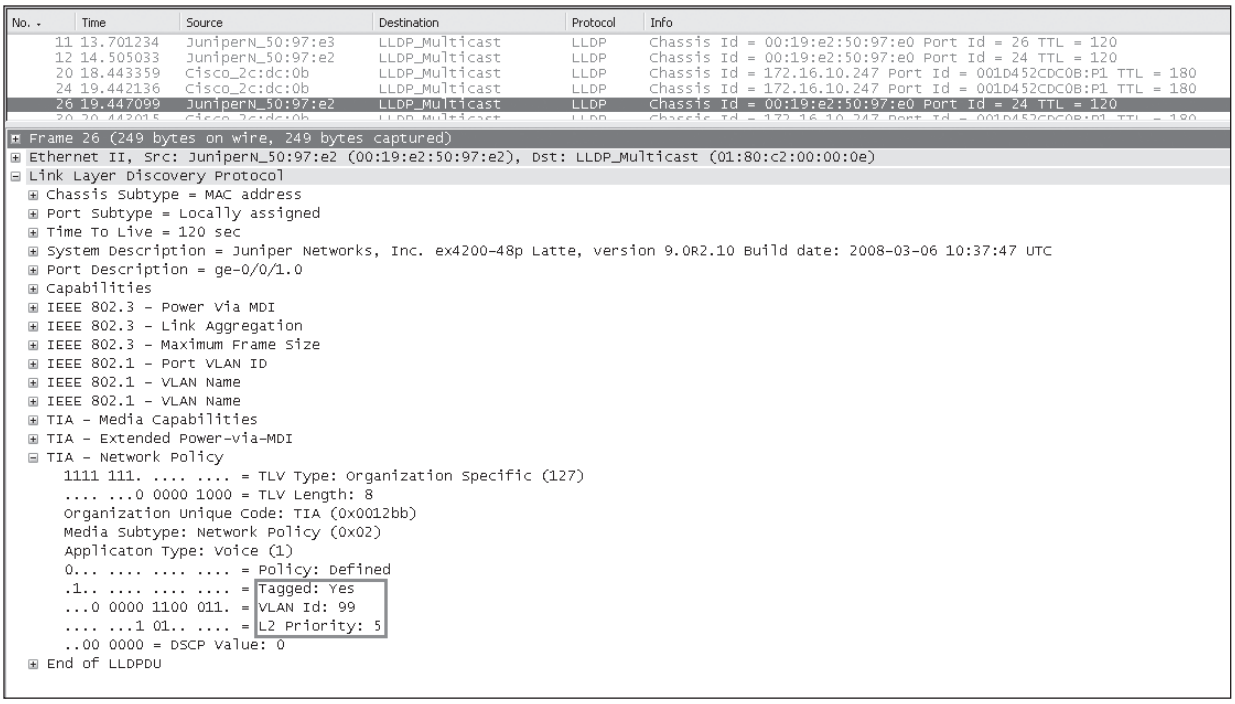
No. Time Source Destination Protocol Info
11 13.701234 JuniperN_50:97:e3 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 26 TTL = 120
12 14.505033 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
20 18.443359 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
24 19.442136 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
26 19.447099 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
Frame 26 (249 bytes on wire, 249 bytes captured)
Ethernet II, Src: JuniperN_50:97:e2 (00:19:e2:50:97:e2), Dst: LLDP_Multicast (01:80:c2:00:00:0e)
Link Layer Discovery Protocol
Chassis Subtype = MAC address
Port Subtype = Locally assigned
Time To Live = 120 sec
System Description = Juniper Networks, Inc. ex4200-48p Latte, version 9.0R2.10 Build date: 2008-03-06 10:37:47 UTC
Port Description = ge-0/0/1.0
Capabilities
IEEE 802.3 - Power Via MDI
IEEE 802.3 - Link Aggregation
IEEE 802.3 - Maximum Frame Size
IEEE 802.1 - Port VLAN ID
IEEE 802.1 - VLAN Name
IEEE 802.1 - VLAN Name
TIA - Media Capabilities
TIA - Extended Power-via-MDI
TIA - Network Policy
1111 111. .... = TLV Type: Organization Specific (127)
....0 0000 1000 = TLV Length: 8
Organization Unique Code: TIA (0x0012bb)
Media Subtype: Network Policy (0x02)
Applicaton Type: Voice (1)
0... .... = Policy: Defined
.1.. .... = Tagged: Yes
...0 0000 1100 011. = VLAN Id: 99
....1 01.. .... = L2 Priority: 5
..00 0000 = DSCP Value: 0
End of LLDPDU

Figure 9: EX Series Ethernet Switch advertising network policy for VoIP phone via LLDP-MED

Once the EX Series Ethernet Switch determines that the connected device is LLDP-MED-capable, it will advertise its capabilities and defined network policy via LLDP-MED. In Figure 10, the VLAN ID used for voice is set at 99 as configured.

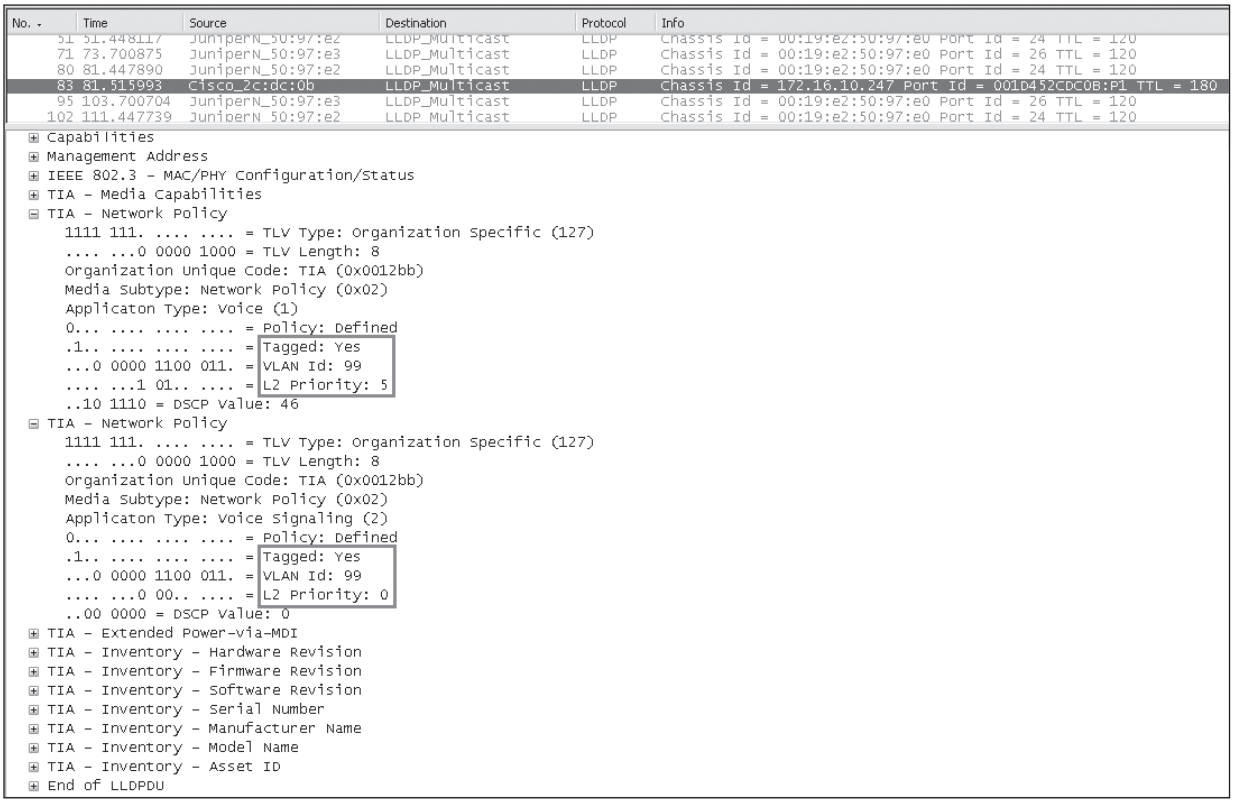
No. Time Source Destination Protocol Info
71 73.700875 JuniperN_50:97:e3 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 26 TTL = 120
80 81.447890 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
83 81.515993 Cisco_2c:dc:0b LLDP_Multicast LLDP Chassis Id = 172.16.10.247 Port Id = 001D452CDC0B:P1 TTL = 180
95 103.700704 JuniperN_50:97:e3 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 26 TTL = 120
102 111.447739 JuniperN_50:97:e2 LLDP_Multicast LLDP Chassis Id = 00:19:e2:50:97:e0 Port Id = 24 TTL = 120
Capabilities
Management Address
IEEE 802.3 - MAC/PHY Configuration/Status
TIA - Media Capabilities
TIA - Network Policy
1111 111. .... = TLV Type: Organization Specific (127)
....0 0000 1000 = TLV Length: 8
Organization Unique Code: TIA (0x0012bb)
Media Subtype: Network Policy (0x02)
Applicaton Type: Voice (1)
0... .... = Policy: Defined
.1.. .... = Tagged: Yes
...0 0000 1100 011. = VLAN Id: 99
....1 01.. .... = L2 Priority: 5
..10 1110 = DSCP Value: 46
TIA - Network Policy
1111 111. .... = TLV Type: Organization Specific (127)
....0 0000 1000 = TLV Length: 8
Organization Unique Code: TIA (0x0012bb)
Media Subtype: Network Policy (0x02)
Applicaton Type: Voice Signaling (2)
0... .... = Policy: Defined
.1.. .... = Tagged: Yes
...0 0000 1100 011. = VLAN Id: 99
....0 00.. .... = L2 Priority: 0
..00 0000 = DSCP Value: 0
TIA - Extended Power-via-MDI
TIA - Inventory - Hardware Revision
TIA - Inventory - Firmware Revision
TIA - Inventory - Software Revision
TIA - Inventory - Serial Number
TIA - Inventory - Manufacturer Name
TIA - Inventory - Model Name
TIA - Inventory - Asset ID
End of LLDPDU

Figure 10: LLDP-MED-capable phone advertising changed network policy per the EX Series Ethernet Switch

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The LLDP-MED-capable VoIP phone now sets VLAN ID 99 for both voice and voice-signaling traffic in its LLDP-MED network policy in response to the LLDP data unit it received previously.

Phones without LLDP-MED Support

While organizations can derive great benefits by using LLDP-MED-capable VoIP phones, the fact is that most existing VoIP deployments don't support the protocol, and businesses are unlikely to incur the cost required to upgrade these devices. In such cases, there are several other IP telephony methods available that the EX Series can support. Each of these solutions, however, has some unique requirements.

Using Access Port with Voice VLAN Feature (but without LLDP-MED)

Although the Voice VLAN feature delivers the greatest benefit when coupled with LLDP-MED-capable VoIP phones, it is flexible enough that non-LLDP-MED-capable phones can also use it effectively. However, such a configuration requires that the Voice VLAN feature be set manually on the VoIP phones themselves, since LLDP-MED is not available to accomplish this dynamically.

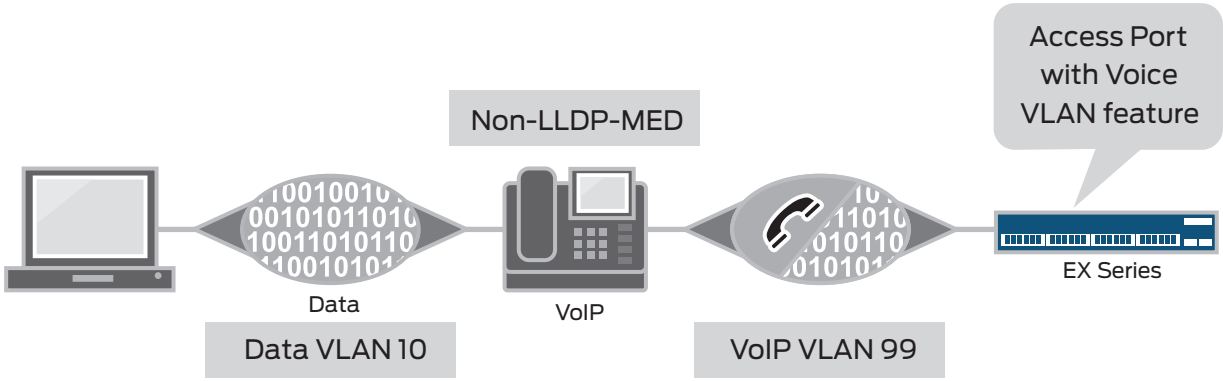

Figure 11: Access port with voice VLAN feature

Once the Voice VLAN ID and other relevant parameters have been manually set on the VoIP phone to match the settings configured on the EX Series, the feature behaves the same as it does when configured with LLDP-MED-capable VoIP phones.

Using Access Port with the Same VLAN ID for Both Voice and Data

Another way to deploy an IP telephony solution is to assign both the VoIP phone and the end-host machine to a single VLAN. This is the simplest configuration among the methods discussed in this document.

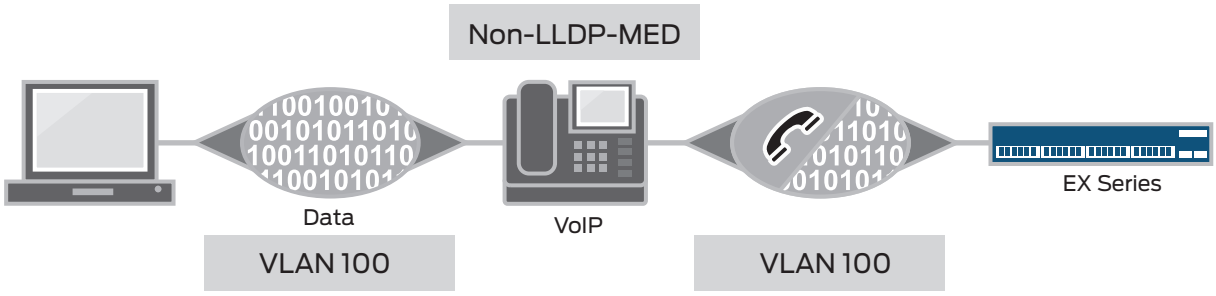

Figure 12: Both VoIP phone and endpoint device in the same VLAN

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The configuration is performed as follows:

```
user@switch# set vlans voice-and-data vlan-id 100
user@switch# set interfaces ge-0/0/1 unit 0 family ethernet-switching port-mode
access
user@switch# set interfaces ge-0/0/1 unit 0 family ethernet-switching vlan member
voice-and-data
user@switch# commit
```

Although this method is technically feasible, it is not a recommended configuration because placing both data and voice traffic on the same VLAN leaves the voice traffic prone to potential jitter, delay and packet loss—conditions that are introduced by "bursty" data traffic.

Using Trunk Port with Native-VLAN Option

Using a switch trunk port where the VoIP phone and endpoint host are connected will create the desired separation between voice and data traffic, but it requires some additional configuration on both the switch and the VoIP phone.

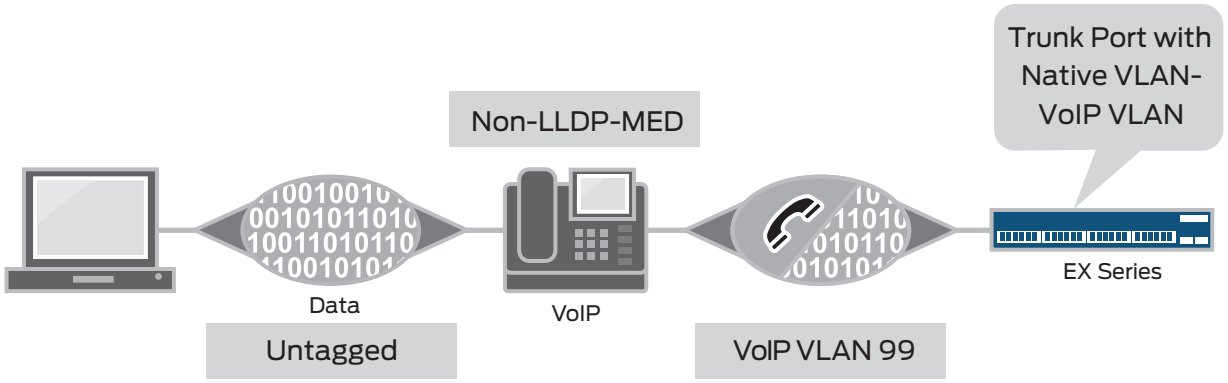

Figure 13: Trunk port with Native-VLAN option

A sample trunk configuration is provided below:

```
user@switch# set vlans voip-only vlan-id 99
user@switch# set vlans data-only vlan-id 10
user@switch# set interfaces ge-0/0/1 unit 0 family ethernet-switching port-mode
trunk
user@switch# set interfaces ge-0/0/1 unit 0 family ethernet-switching vlan member
[ voip-only ]
user@switch# set interfaces ge-0/0/1 unit 0 family Ethernet-switching native-
vlan-id data-only
user@switch# commit
```

Let's look at this particular configuration in greater detail. Similar to the Voice VLAN feature, two VLANs are configured here: voip-only and data-only.

```
user@switch# set interfaces ge-0/0/1 unit 0 family ethernet-switching port-mode
trunk
user@switch# set interfaces ge-0/0/1 unit 0 family ethernet-switching vlan member
[ voip-only ]
```

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However, in this case the interface is configured as a trunk that includes only the voice VLAN. In order to separate the voice and data traffic, the trunk port will transmit and receive only tagged traffic on the trunk VLAN member list, which in this case is the voip-only VLAN.

Since a typical endpoint host such as a desktop or laptop will send its packets untagged (which will subsequently be relayed by the VoIP phone), the corresponding switch trunk port must be configured with the "native-vlan-id" option in order to transmit and receive untagged traffic belonging to the native VLAN, which in this case is the data-only VLAN. Otherwise, untagged packets sent from the endpoint host and relayed by the phone would be dropped on the switch trunk port by default, since the packets are untagged.

```
user@switch# set interfaces ge-0/0/1 unit 0 family Ethernet-switching native-
vlan-id data-only
```

Description and Deployment Scenario—Method 2: Separate Ports for VoIP Phone and Endpoint Device

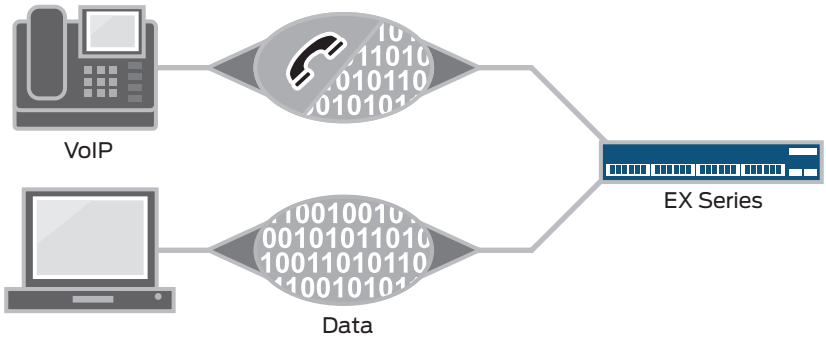

Figure 14: Separate ports for VoIP and endpoint device

In contrast to the shared switch-port configuration discussed earlier, VoIP phones (LLDP-MED-capable and non-capable) and endpoint hosts can also occupy their own ports. This is not a typical IP telephony deployment in the enterprise today, where cost reduction is a priority, but there are cases where endpoint devices would occupy their own ports, mainly for management, troubleshooting and maintenance purposes.

Assigning Each Port as Access Port for Different VLAN

When attaching VoIP phones and endpoint devices to their own ports, one approach is to assign each port to different VLANs, so that the port connected to the VoIP phone is configured for voice traffic and the port connected to the endpoint host is configured for data traffic.

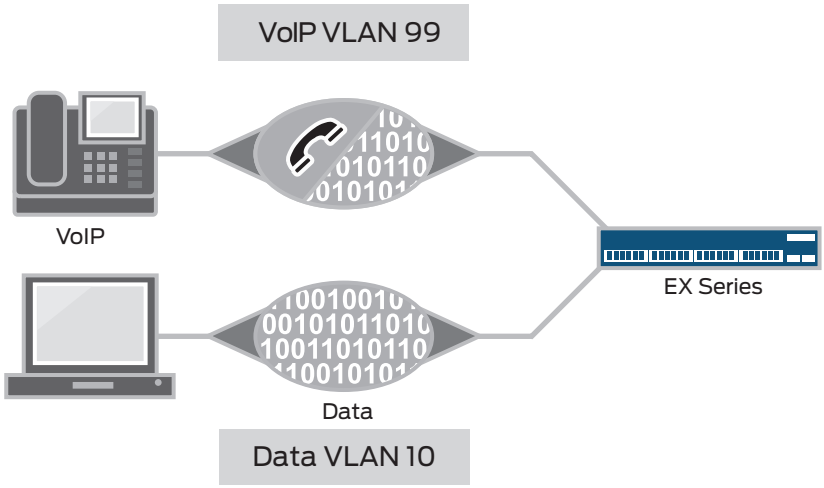

Figure 15: Each port as access port for different VLAN

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This configuration is very straightforward; examples discussed previously in this document can be used as reference. Furthermore, this method does not require any manual settings on either the VoIP phone or the endpoint host, as they already belong to the correct domain as soon as they are physically connected.

Assigning Both Ports as Access Ports for Data VLAN with Voice VLAN Feature

Another two-port option is to assign both ports (where the VoIP phone and endpoint host are connected) into the data VLAN and then configure the Voice VLAN feature. Manual configuration may be required if the VoIP phone is not LLDP-MED-capable. The actual configuration is very similar to the configuration shown in the Access Port with Voice VLAN section.

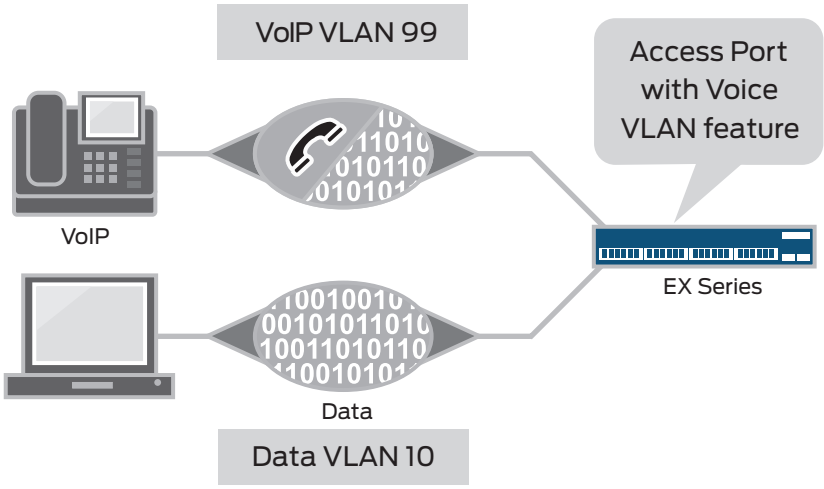

Figure 16: Both ports as access ports of data VLAN with voice VLAN feature

Conclusion

When implementing an IP telephony solution, there are a number of options to consider before committing to the actual deployment. This application note has discussed a variety of methods for implementing an IP telephone solution, including the physical layout of VoIP phones and endpoint devices, the Voice VLAN feature of the EX Series, LLDP and LLDP-MED, and more. These methods and technologies can and will make a difference in the successful implementation of an IP telephony solution.

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